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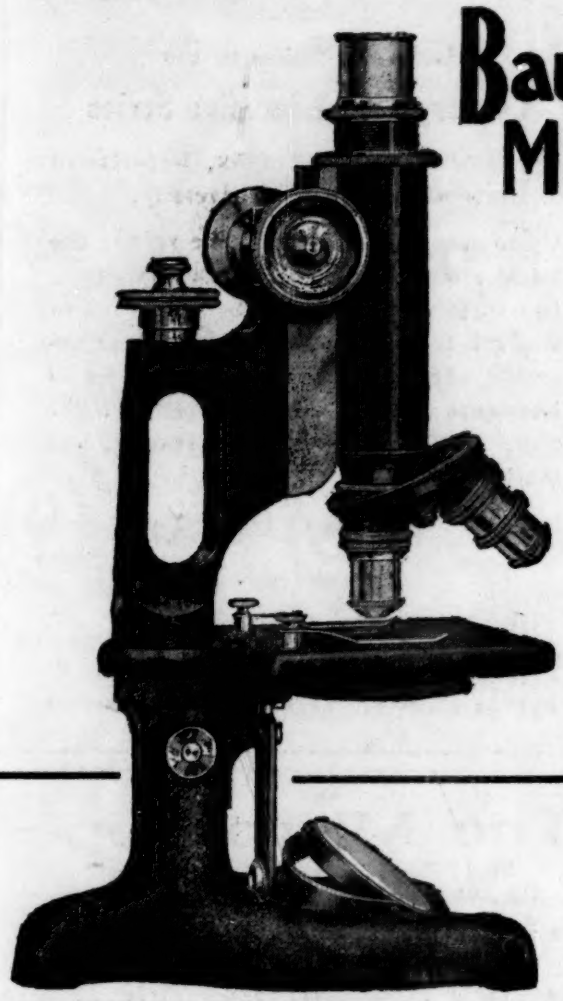

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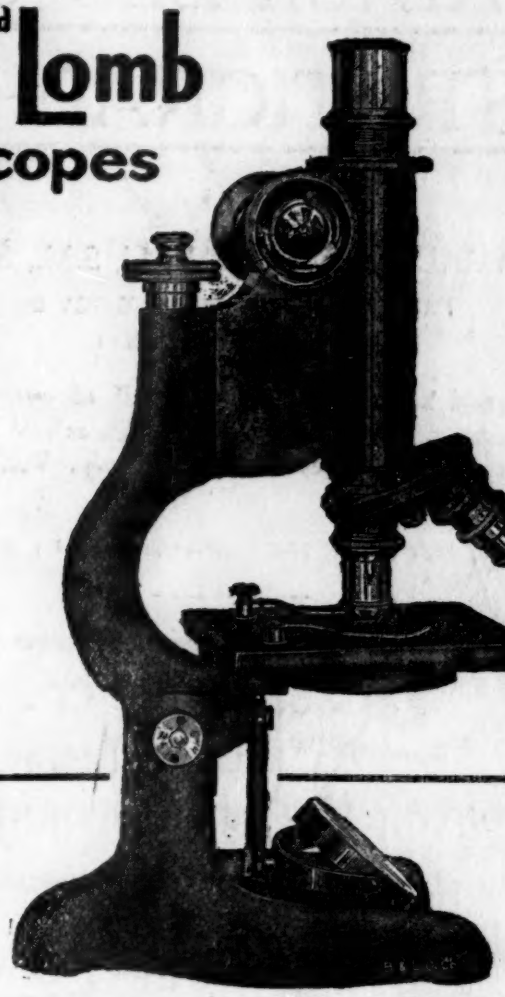

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SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE IMPORTANCE OF MOLD ACTION IN SOILS[1]

THE development of soil bacteriology during the last decade has been truly remarkable. Many fundamental problems connected with the occurrence and activities of bacteria in soils have been attacked and considerable progress has been made toward their solution. While much work still remains to be done along this line, results already secured show, in a rather definite way, the importance of bacterial action in soils from the fertility standpoint.

According to recent investigations, however, bacteria are not the only microorganisms which exert an influence on soil fertility. Molds, protozoa and algæ have been found quite commonly, and evidently their action, especially that of molds, must also be considered in determining the crop-producing power of soils. The subject of microorganic life in the soil has, therefore, been considerably broadened and complicated.

The occurrence of molds in soils has been noted many times in the past in connection with bacteriological and other studies and various investigations have dealt in a more or less general way with the action of these organisms. It is only within the last year, however, that an attempt has been made in a logical and comprehensive manner to study the occurrence, distribution and activities of molds in soils, and to solve some of the fundamental problems which arise in connection with the growth of these organisms. The results secured at the New Jer-

[1] Paper presented at the meeting of the Society of American Bacteriologists, at New Haven, Conn., December 27, 1916.

sey Agricultural Experiment Station,[2, 4, 5] not only furnish a basis upon which future experiments may rest, but they also indicate quite distinctly that the growth of molds in the soil may be of great significance.

The transformation of organic and inorganic compounds in the soil has long been considered the particular function of soil bacteria, but molds may also play an important rôle in such processes, and indeed it is conceivable that in some instances they may prove largely responsible for the simplification of complex soil materials.

It is not the purpose of this paper to review the previous studies on molds, for excellent bibliographies have been presented in the work of Waksman[4] and Coleman[2] already referred to. It is desired merely to call attention in a brief way to the varied action of molds in soils, and to present a compilation of various published data and some of our own unpublished results along this line, with the idea of emphasizing the need of further study of these organisms.

In the first place, the number of molds in soils should be considered, and while data along this line are far from conclusive, it has been shown that large numbers of these organisms are always present. Especially is this true for soils rich in humus, and acid in reaction. But the occurrence of fungi is not restricted to such abnormal soils. Neutral, well-aerated and well-fertilized soils are also found to contain rich mold floras. Furthermore, fungi are not limited merely to the surface soil, but occur in the deeper soil layers. The well-known predilection of certain fungi for acid conditions has been confirmed and leads to interesting conclusions regarding the special importance of these forms in acid soils in which beneficial bacterial action is largely restricted.

A very important point in connection with the occurrence of molds in soils has been studied recently by Waksman.[5] While the counting methods employed have shown the large numbers of molds in soils, considerable doubt existed as to whether these counts represented the actual number of active fungi or only the spores. If spores alone are present, the activity of molds in soils may be of less immediate importance although their presence would indicate previous active growth as well as future activity when the soil conditions become satisfactory for the development of active forms from the spores. Active mold growth on the other hand would undoubtedly be of immediate importance in the chemical changes occurring in the soil. The value of definite information along this line is apparent. The careful experiments of Waksman show that many molds occur in soils in an active state as well as in the form of spores. While certain groups do not appear to be present in an active condition in the soils tested, although the plate method showed their occurrence as spores, studies of other soils may lead to different conclusions.

Conn[3] has attempted to check Waksman's results by the use of smaller quantities of soil, but was unsuccessful. Using 10 mg. of soil, he secured no growth of mold mycelia such as Waksman obtained with lumps of soil 1 cm. in diameter. He describes a direct microscopic examination of soils and finds no mold mycelia present. He concludes from these experiments that there is serious doubt whether molds exist in soils in an active form *in sufficient num-*

[2] Coleman, D. A., "Environmental Factors Influencing the Activity of Soil Fungi," *Soil Science*, Vol. II., No. 1, p. 1.

[3] Conn, H. J., "Relative Importance of Fungi and Bacteria in Soil," Science, N. S., 44, p. 857.

[4] Waksman, S. A., "Soil Fungi and Their Activities," *Soil Science*, Vol. II., No. 2, p. 103.

[5] Waksman, S. A., "Do Fungi Actually Live in the Soil and Produce Mycelium?" Science, N. S., 44, p. 320.

bers to be important compared with bacteria. There seem to be two questions involved here: How large a proportion of the number of molds developing on plates represent active forms and how many spores? What is the number of active mold forms which need be present in the soil for them to be considered important in the various soil chemical processes?

The first of these questions is rather difficult to answer at the present time, but our experiments indicate that rather a large proportion of the total number of molds present in various soils occur in the active state. We have found active mold growth occurring in all the soils thus far examined, and we have used both Waksman's and Conn's methods. Our results confirm Waksman's observations, therefore, and Conn's criticism seems unwarranted, for *active mold mycelia have developed in all our tests, using not only 10 mgs. but also smaller quantities of soils, as well as* the larger lumps employed by Waksman. The soils tested are normal soils, many of them untreated and none extremely rich in humus.

Further work along this line is certainly desirable, but from our observations thus far there seems no doubt but that *fungi occur actively in soils,* and hence we feel that their action must be important regardless of their relative numbers compared with bacteria. Furthermore the presence of spores is likewise important for they may become active in the near future and bring about their characteristic reactions. The answer to the second question mentioned above can only come after long-continued experiments, but from the vigorous action of molds noted in so many cases, as will be pointed out later, it is evident that the problem of microorganic activity in relation to soil fertility can not be completely solved without a knowledge of mold growth. Perhaps they are not as important as bacteria, there is no means yet of knowing, but even if of secondary significance they deserve recognition. Our present knowledge of soil fertility is too incomplete to permit us to pass over hastily any possibly important factors without thorough study.

We believe, therefore, that molds occur in most soils, both in the active and in the spore state, and hence they must pass through their various life cycles in the soil. Furthermore, different soils undoubtedly have different fungus floras. Species present under one combination of conditions may be absent under others. Organisms present only as spores in one case may occur actively in other instances. Finally, it seems perfectly possible that the relative occurrence of active and spore forms of various organisms may vary in the *same* soil with varying conditions of moisture, temperature, aeration, reaction and food supply.

Considering the occurrence of molds in an active state in all soils an established fact, the importance of these organisms in the decomposition of the soil organic matter becomes evident. Many experiments have been conducted along this line and it has been very clearly demonstrated that molds are very efficient ammonifiers. Indications have been secured that there exists a correlation between the biological stage of the organisms and the periods of ammonia accumulation. The largest amount seems to accompany the periods of spore germination and the smallest amount the time preparatory to actual spore formation.

All the nitrogenous organic materials which make up the humus content of soils are easily attacked by various fungus forms and ammonia is liberated in large amounts. Part of this ammonia may, of course, be utilized by them, but by far the larger part

is set free and may be subsequently nitrified for use by the higher plants. Various fertilizing materials containing complex nitrogenous compounds may be ammonified by soil fungi, and their decomposition considerably facilitated. For instance, experiments with cyanamide show its rapid transformation to ammonia by certain molds. Ammonia production from urea by molds has also been definitely proven.

The non-nitrogenous portion of the soil organic matter is also attacked by many molds. Thus experiments have shown that cellulose is rapidly decomposed by many species, and other substances such as sugars, pectins, oils, fats, waxes, organic acids, etc., are likewise broken down by molds. Some recent results secured in our laboratories show the large carbon-dioxide production by molds. No doubt, therefore, remains but that these organisms play an extremely important part in the decomposition of all soil organic matter and indeed certain results indicate that their action along this line may be much greater than that of bacteria, at least under certain soil conditions.

No experiments have yet been reported which indicate that molds may bring about nitrification, and this process, therefore, still appears to be purely bacteriological. Further experiments may modify this conclusion.

Denitrification and deazotofication, however, processes now known to be of slight significance in normal soils, but which may occur in highly manured, specially treated greenhouse and market garden soils, may possibly be brought about by the action of molds. The introduction of these organisms with the manure used may be an important factor here. Definite data along this line are lacking at the present time.

Non-symbiotic nitrogen fixation, or azofication by molds has been studied from time to time and indications have been secured that certain species may be able to utilize the nitrogen of the atmosphere. The results, as a whole, however, are far from satisfactory and indeed the conclusion has been drawn that at the present time the "weight of the conclusions on the fixation of nitrogen by fungi seems to be on the negative side." Further experiments along this line are certainly desirable.

The utilization of various nitrogen compounds by molds has been studied to some extent, and it has been found that ammonia and nitrate compounds are assimilated by these organisms in considerable amounts. Thus under extreme conditions of mold growth it is conceivable that molds may be actual competitors with the higher plants for nitrogenous food materials. It is not believed, however, that such conditions would occur except very rarely. A knowledge of mold growth in soils may be of some significance, nevertheless, in connection with the questions involved in the fertilization of soils with nitrates and ammonium salts.

The decomposition of mineral compounds in soils by molds has been studied only to a very slight extent. Data secured in our laboratories very largely in connection with certain chemical and bacteriological studies indicate, however, that these organisms may play an extremely important rôle, not only in preparing nitrogenous food materials for plants as has been indicated, but also in making other mineral constituents available. Complete data along the various lines indicated will be published later.

Studies of the production of available phosphorus by bacteria and molds have shown the vigorous action of various fungi in this direction. Several experiments carried out by various methods have shown that rock phosphate is apparently transformed much more rapidly into a soluble form by many molds than by bacteria. The importance of further study along this line

in connection with the solution of the moot question regarding the relative merits of rock phosphate and acid phosphate can readily be seen.

The oxidation of sulfur in the soil, or sulfofication, a process which has recently received some attention and which gives evidence of being of great importance from the soil fertility standpoint has been shown to be accomplished by several species of molds. The action of these organisms in this process may become of special importance in connection with the recent suggestion for the production of available phosphorus by composting rock phosphate, sulfur and soil or manure.

The process of ferrification, or iron oxidation in soils, while largely chemical in nature according to results thus far secured, is brought about partly by microorganisms and certain molds are apparently much more active in this action than any of the bacteria studied.

Experiments on the production of available potassium by molds should also yield interesting results. No data have yet been secured on this point.

In fact, it seems evident that mold action in soils may be of far greater significance than has previously been supposed in preparing available food for plant growth. No longer should the study of microorganic activities in soils consider bacteria alone. Mold action must also be investigated, and in most cases it is undoubtedly true that only vague, incomplete results can be secured if such mold studies are not included. Many results secured in bacteriological investigations might be explained and interpreted much more clearly and definitely if the activities of molds were considered.

If soil bacteriology is to be developed to the proper extent in the future and the relation of microorganisms to soil fertility is to be established with any degree of certainty, investigations must include not only bacterial action, but the activities of molds and possibly also the growth of protozoa and algæ.

It is certainly desirable that the investigations of molds in soils and their activities and importance be carried out much more generally and on a larger scale than is the case at present. Here is a field of study rich in possibilities and the importance of work along these lines can not be questioned.

P. E. BROWN
IOWA AGRICULTURAL EXPERIMENT STATION

THE U. S. BIOLOGICAL STATION AT BEAUFORT, N. C., DURING 1916

THE general appearance of the site of the station was materially enhanced during the year by enlarging the improved portion of the grounds, and by planting grass, sea oats, trees, and shrubbery. Through these improvements the comfortableness of the station was also increased. The laboratory, as usual, was open during the summer to special investigators. The investigators, with a single exception, had engaged in research at this station before and they continued during the past season lines of work previously undertaken.

The present large series of experiments in diamond-black terrapin culture, which was started in 1909, has progressed with marked success. Several new experiments in addition to those already under way were undertaken. There are now approximately 1,600 terrapins, exclusive of the young of 1916, in the pounds which are being used for experimental purposes. This experimental work has shown quite conclusively that terrapins can be grown and kept in vigorous condition in captivity, for some of the earliest broods, hatched in the pounds at the station, have reached maturity and are very prolific in the production of eggs, and the offspring is equally as vigorous as that of the wild terrapins confined after maturity had been attained.

A total of 2,611 terrapins hatched during the summer of 1916 has to date been taken from the egg beds. This number will be some-

what increased in the spring when terrapins appear that were overlooked in the fall. Among these young removed from the egg beds there are 666 which are offspring of terrapins reared in captivity. The total number of young produced during the previous year, including those found in the spring, was 2,128; of these 50 were offspring of terrapins grown in captivity. It has been known for some time that a female terrapin may lay twice during a single season, but during the past season through the discovery of 12 nests, averaging 8 eggs to a nest, in a pen where only four females are confined, it is evident that a female may lay as often as three times during a single season.

The most gratifying results of the past year are the unusually rapid growth of the young of one year and less of age and the very low mortality. The death rate among the 1915 brood during the first year was about 8 per cent., while formerly it occasionally ran as high as 40 per cent. The death rate among the young after the age of one year or more is attained is negligible.

The observations on the habits of fishes was continued by the director of the station. It is very noteworthy that food fishes generally were unusually scarce in the Beaufort region during the past year. The "gray trout" (*Cynoscion regalis*) which is normally, with perhaps a single exception, the most important food fish of the locality, was so scarce that the fishery was almost wholly abandoned. The almost total failure of a "run" of the two important fall species, the spot (*Leiostomus xanthurus*) and the jumping mullet (*Mugil cephalus*), is equally as noteworthy.

The pig fish (*Orthopristis chrysopterus*) was found in spawning condition on the inner shore of Shackelford Banks during May and the early part of June, but the eggs of this species seem to be difficult to hatch artificially. Spawn taken in the field by stripping was brought to the laboratory for hatching, but these efforts failed. Then ripe or nearly ripe fish were confined in live cars and tanks. Those in the live cars were stripped when apparently very ripe, and those in the tanks were allowed to spawn naturally. At no time was fertilization obtained in eggs artificially spawned, but of those spawned naturally, a small percentage was successfully fertilized and cell division ensued, but all died before hatching. These experiments having failed, the eggs, which are semibuoyant in sea water, were taken by means of a tow-net and brought to the laboratory. These too died before hatching. The methods of hatching employed were those which are usually successful with other species.

The study of the life history of *Gambusia* was continued chiefly for the purpose of verifying observations of previous seasons. In connection with the study of fishes in relation to the mosquito problem, it was found that the common eel (*Anguilla rostrata*) may, at least under more or less abnormal conditions, be of value as an eradicator of mosquito larvæ, for small specimens taken from reservoirs receiving the overflow of an artesian well were found to have subsisted chiefly on mosquito larvæ, which in this instance constituted about the only food available. These eels were not confined in these reservoirs, but had come there through choice by passing from salt water through the overflow from the reservoirs, a passage which remained open for an exit as well as an entrance. This then indicates that the common eel should not be overlooked in the study of fishes in relation to the destruction of the mosquito. Several collecting trips to fresh-water ponds and streams in the vicinity of the laboratory yielded the following species of fishes which do not seem to have been recorded from this immediate vicinity; *Ameiurus erebennus* Jordan, *Ameiurus catus* (Linnæus), *Erimyzon sucetta* (Lacépède), *Notemigonus crysoleucas* (Mitchill), *Notropis procne* (Cope), *Dorosoma cepedianum* (LeSueur), *Esox americanus* Gmelin, *Esox reticulatus* LeSueur, *Aphredoderus sayanus* (Gilliams), *Centrarchus macropterus* (Lacépède), *Chænobryttus gulosus* (Cuvier & Valenciennes), *Enneacanthus gloriosus* (Holbrook), *Lepomis gibbosus* (Linnæus), *Lepomis incisor* (Cuvier & Valenciennes), *Micropterus salmoides* (Lacépède), *Perca flavescens*

(Mitchill), *Boleosoma olmstedi* (Storer), *Copelandellus quiescens* (Jordan). The two marine species, *Synodus intermedius* (Agassiz) and *Myrophis punctatus* Lütken, appear to be new to the Beanfort fauna.

Dr. Albert Kuntz, of the St. Louis University School of Medicine, continued the study of the embryological and larval development of fishes carried on during several seasons. Experiments in rearing larvæ gave only negative results.

Dr. Kuntz also made a detailed study of the skin of flounders adapted to backgrounds of different colors for the purpose of determining the degree of distribution of melanin and xanthine pigment and the relationship of the guanophores with the chromatophores when a given shade or color is assimilated as nearly as possible. Shade was found to depend primarily on the degree of distribution of the melanin pigment and the relationship of the guanophores with the melanophore. Color depends on a complex group of factors including the relative degree of distribution of melanin and xanthine pigment and the optical effects due to the diffraction of light by the guanin crystals in the guanophores.

Mr. Arthur Jacot, of Cornell University, continued for the second season the study of the life history of the mullets of the Beaufort region. It was definitely determined that the nominal genus *Querimana* comprises the young of the genus *Mugil*. At a certain period in their lives the young mullets pass through a gradual change which gives them the full adult characters. During this time the first soft ray of the anal fin is transformed into a spine, a change in the sculpture of the scales giving the appearance of a winter line also takes place, and the color is changed more nearly to that of the adult. The "jumping mullet" (*Mugil cephalus*) spawns in the fall, from October to December. The young grow rapidly and attain a length of 5 or 6 inches when one year of age. Then they appear to migrate southward by a slow and leisurely movement. In the spring they migrate northward, but by a more direct and apparently more continuous run. This migration causes a cessation of feeding and therefore of growth which is so marked as to affect the scale, leaving a "migration line." The jumping mullet, as shown from these studies, normally attains maturity when two years of age, but it may continue to grow until at least five years old. The "silverside mullet" (*Mugil curema*) spawns in the spring and the young grow rapidly. In the fall they leave the harbor to return only in small numbers. A careful search was made for the eggs and larvæ within the harbor and along the outer shores of Shackelford and Bogue banks, but no eggs or young less than 20 mm. in length were found. Since the eggs and larvæ of the jumping mullet too have not been found by the use of similar methods in the same locality, it is inferred that these two species are pelagic in their spawning grounds.

Mr. O. W. Hyman, of the University of Tennessee, continued his experiments and observations on the larval development of crustaceans. The experiments in rearing zoeæ were unsuccessful, but the observational work yielded better results. The first zoea stages of *Minippe* and *Callinectes* were secured, but could not be reared beyond this stage. Scattered observations were made on the life history and habits of *Minippe*. The megalops of *Callinectes* were taken in abundance and it was found that they were hardly in confinement and molted readily to the crab stage. The young crabs molted and grew rapidly. The entire life history of the common sand-fiddler (*Uca pugilator*) was worked out. Camera lucida drawings were prepared of each stage and of all appendages of each stage.

Dr. James J. Wolfe, of Trinity College, Durham, N. C., continued his investigation of the diatom flora of the Beaufort region. This work has been greatly hampered by the difficulty encountered in securing the very scattered literature on the subject. It is proposed in the present work to give carefully revised citations and descriptions of every form occurring in the vicinity. It is also proposed to offer carefully prepared illustrations of the commoner forms.

In addition to the above Dr. Wolfe, assisted

by Mr. Bert Cunningham, of the Durham, N. C., city schools, began an investigation of the plankton collections made by the U. S. Fisheries steamer *Fish Hawk* in the Chesapeake Bay region. Some thirty-odd collections were examined by the employment of methods which it is believed will furnish fairly accurate data concerning the numerical relations of all the important species as they vary according to depth, season and locality.

Dr. L. F. Shackell, of the University of Utah, continued his studies on the toxicities of various constituents of coal-tar creosote for the marine wood borer, *Limnoria*. Among the preparations tested were composite samples of tar bases of different boiling points, obtained through the courtesy of Mr. S. R. Church, of the Barrett Manufacturing Company. It was found that the bases were highly toxic for *Limnoria;* and that the toxicity increased with the rise of the boiling point—paralleling in this respect the results previously obtained for the tar acids.

Professor H. V. Wilson, of the University of North Carolina, spent a short time at the laboratory, continuing the study and identification of the "Albatross-Philippine Sponge Collection." Since but little work had previously been done on the sponges of the far east, it is not surprising that many of the forms proved to be undescribed.

Mrs. E. Bennet Decker, of Washington, D. C., again served as station artist. She prepared a number of illustrations of diatoms for Dr. Wolfe and made drawings and sketches for Dr. Kuntz and for the director.

Samuel F. Hildebrand,
Director

Bureau of Fisheries,
Washington, D. C.

PHILIPPE DE VILMORIN

With the death of Philippe Levêque de Vilmorin on June 30, genetics and horticulture lost a remarkable friend. His published work in both fields is valuable, but perhaps surpassed by his personal influence, which he owed largely to his position as head of the large and wealthy de Vilmorin family, and of the firm of Vilmorin, Andrieux & Co., of Paris, one of the most celebrated seed-growing and seed-selling establishments in the world.

The firm first appears in 1727 as a little seed store "*Aucoque de la bonne foy*" on the bank of the Seine, kept by one Pierre Geoffroy, whose daughter and heiress married the botanist Pierre d'Andrieux. A young botanist from Lorraine, Philippe-Victoire Levêque de Vilmorin, formed an intimacy with Andrieux, and in 1774 married his only daughter. Since then the firm has borne the name of the two families, although controlled wholly by the de Vilmorins. It has been handed on from father to son, and many of the family have contributed to agricultural science. The best known is Louis de Vilmorin (1816–1869), whose name is always connected with the sugar beet.

Of the early French contributors to genetics some, like Victor Lemoine, are known only as practical hybridizers; others have done purely theoretical work, as Jordan with his study of the nature of species, and Naudin with his observations on the segregation of characters in hybrids. Louis de Vilmorin is conspicuous in both classes. To theory he contributed the centgener method of breeding; to practical agriculture he contributed the sugar beet, whose saccharine content he raised from 10 per cent. to 18 per cent. by a carefully planned series of selections. Little improvement has been made in this beet since it left his farm.

He was succeeded by his son Henri, as head of the business and the family, and Philippe, who has just died, succeeded Henri in 1899. Philippe turned over the active management of the family business to his brother-in law, Comte d'Etienne, and gave the greater part of his own time to scientific research.

In horticulture he published studies of the beet-sugar industry of the United States, the culture of ginseng in Korea and Manchuria, and the tobaccos of commerce. He likewise edited three important publications of the firm: *Les Fleurs de Pleine Terre, Le Manuel de Floriculture,* and the *Hortus Vilmorinianus.*

The most important of his published work in genetics deals with wheat, but he also carried on a long series of dog-breeding experiments and, through the firm, made possible the researches of Hagedoorn, Meunissier, Mottet and other geneticists. He was largely responsible for the Fourth International Conference on Genetics, held in Paris in 1911. As secretary, he did most of the work connected with it; as financial guarantor, he furnished most of the funds needed for it. The large volume of *Proceedings,* which he edited and published at his own expense, is a fitting memorial to his zeal in the promotion of scientific research.

PAUL POPENOE

WASHINGTON, D. C.

SCIENTIFIC EVENTS

THE PRODUCTION OF IRON ORE AND PIG IRON IN 1916

THE iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made. The shipments from the mines in 1916 were 77,870,553 gross tons, valued at $181,902,277. The quantity mined in 1916 was more than 19,600,000 tons greater than that mined in 1915. The increases in quantity and in value of iron ore shipped in 1916 amounted to about 40 and 80 per cent., respectively. The average value per ton at the mines in 1916 was $2.34, as against $1.83 in 1915. These figures, which were compiled under the direction of E. F. Burchard, of the United States Geological Survey, Department of the Interior, include for 1916 only iron ore containing less than 5 per cent. of manganese.

Iron ore was mined in 24 states in 1916 and 23 in 1915. Minnesota, Michigan and Alabama, which have for many years produced the largest quantities of iron ore, occupied in 1916 their accustomed places.

The Lake Superior district mined nearly 85 per cent. of the total ore in 1916 and the Birmingham district about 8 per cent. No other district except the Adirondack mined as much as 1,000,000 tons. The increase in production in 1916 was especially marked in the Adirondack and Chattanooga districts—54 and 55 per cent. respectively—but every district showed an increased output over that of 1915.

All the ranges in the Lake Superior district mined a larger quantity of iron ore in 1916 than in 1915, and the largest increases were in the Gogebic and Menominee ranges—54 and 43 per cent., respectively. The output of the Cuyuna range exceeded 1,500,000 tons for the first time.

There were 12 mines in the United States that produced more than 1,000,000 tons of iron ore each in 1916, five more than in 1915. First place in 1916 was held by the Hull-Rust mine, at Hibbing, Minn.; second place by the Red Mountain group, near Bessemer, Ala.; third place by the Fayal mine, at Eveleth, Minn., and fourth place by the Mahoning mine, at Hibbing, Minn. The production of these mines in 1916 was, respectively, 7,658,201, 2,899,588, 2,252,008 and 2,215,788 tons. The increase at the Hull-Rust was 232 per cent., making the production of this one mine more than one tenth of all the ore mined in the United States in 1916. These records illustrate the rapidity with which the rate of output of mines in the Lake Superior district may be increased. None but open-pit mines could be made to respond to demand to such a degree.

The production of pig iron, including ferro-alloys, was 39,434,797 gross tons in 1916, compared with 29,916,213 gross tons in 1915, an increase of 32 per cent., according to figures published by the American Iron and Steel Institute, February 24, 1917. The pig iron, exclusive of ferro-alloys, sold or used in 1915, according to reports of producers to the United States Geological Survey, amounted to 39,126,324 gross tons, valued at $663,478,118, compared with 30,384,486 gross tons, valued at $401,409,604 in 1915, a gain of 29 per cent. in quantity and 65 per cent. in value. The average price per ton at furnaces in 1916 as reported to the Survey was $16.96, compared with $13.21 in 1915, an increase of 28 per cent.

RESEARCH IN AERONAUTICS

THE report of the British Advisory Committee for Aeronautics for 1916–17 is sum-

marized in the Engineering Supplement of the London *Times*.

It is said that owing to the numerous changes and development in the design and construction of aircraft an increasing number of special problems constantly presented themselves for investigation, and these have closely occupied the attention of the staffs engaged in experimental work at both the National Physical Laboratory and the Royal Aircraft Factory. In addition to aerodynamical research, much attention has been given to questions relating to engines, materials of construction, strength of construction and design, instruments and accessories, as well as to methods of attack of aircraft from aircraft and other matters.

In the new 7 ft. air channel at the National Physical Laboratory an air speed of 85 ft. per second can be reached with an expenditure of 160 h.p. It is doubtful whether further increase in size of channel or speed of air current would advance existing knowledge to an extent sufficient to outweigh the greatly increased cost and other disadvantages involved. Should it prove necessary to conduct experiments on a larger scale and at higher speeds, it would appear necessary to employ a method in which the model is moved through the air. This procedure presents various difficulties, and the securing of even moderately accurate data in this manner is at the best extremely laborious. Probably the least troublesome way of applying this method is by installing measuring apparatus on the aeroplane itself, and it seems probable that only in this way can an accurate comparison be obtained between model and full-scale conditions.

Improved methods of supporting the models under test have been devised for use in special cases. The effect on the measured resistance of the method of holding the model is often surprisingly large, and without the necessary care and experience in avoiding effects due to interference with the air flow very large errors may result. In general the difficulty is greatest in measurements on forms of small head resistance—*e. g.*, aeroplane bodies and airship envelopes. Probably little reliance can be placed on the absolute values obtained in earlier measurements on airship models of stream line shape, which were made to determine the form of least resistance, and were in the main comparative. With the new methods of support the possible error has been greatly reduced, and when full-scale values have been determined with accuracy the prediction of full-scale resistance from the models will be established on a satisfactory basis.

At the Royal Aircraft Factory the measurement of the resistance of aeroplanes in flight has been continued with the object of confirming the model experiments, and an instrument for measuring the resistance directly has been developed. The distribution of pressure over the wing of an aeroplane in flight has been measured, and further experiments on these lines are in progress. Experiments and also much theoretical work have been carried out on the longitudinal and lateral stability of aeroplanes in flight. Measurements have also been made of the disturbance of the air behind a propeller, to obtain data required in the design of new machines.

SCIENTIFIC NOTES AND NEWS

President Raymond A. Pearson, of the Iowa State College, and Clarence Ousley, of the Texas State College, have been appointed to be assistant secretaries of agriculture.

Dr. Ray L. Wilbur, president of Stanford University and formerly professor of medicine, has been placed in charge of the conservation department of the Food Administration.

The Women's Council of Defense announces the following advisory committees: *Food Utilization.*—Professor R. H. Chittenden, Professor Graham Lusk, Professor E. V. McCollum, Professor L. B. Mendel, Dr. C. L. Alsburg, Dr. C. F. Langworthy, Professor Vernon Kellogg, Dr. A. E. Taylor and President Ray L. Wilbur. *Public Health.*—Professor W. H. Welch, chairman, Dr. L. P. Ayer, Dr. Hermann M. Biggs, Dr. D. L. Edsall, Dr. Cary T. Grayson, Dr. A. W. Hewlett, Dr. A. C. Janeway, Dr. F. G. Novy, Dr. R. M. Pearce and Professor H. G. Wells.

Dr. Harriet L. Hartley has been appointed chief of the division of child hygiene,

of the Philadelphia department of health, succeeding the late Dr. Henry H. Doan.

DR. J. B. CLELAND, of the Sydney department of public health, has been elected president of the Royal Society of New South Wales.

MR. ALAN A. CAMPBELL SWINTON has been elected chairman of the council of the Royal Society of Arts, London.

WE learn from *Nature* that early in July Mr. Erik Andersson, of Uppsala, again led to Spitsbergen a geological expedition, which included Messrs. Adam Reuterskiöld, Sven Ydén and Karl Samuelsson. The main object was to continue the investigation of the Trias and to collect saurians and fishes. The occurrence of phosphorite at Cape Thordsen was to be investigated, as well as the extent of the coal beds at Pyramid Hill and Bünsowland. Investigations in the Devonian rocks are to be continued and their vertebrate fossils collected. A large expedition of miners and mining engineers also left Sweden about midsummer to exploit the coal measures of Spitsbergen, and was accompanied by Dr. Anteus as geologist.

THE Committee of the Privy Council for Scientific and Industrial Research has sanctioned the appointment of a committee to inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardized, and to collect evidence bearing on these points. The members of the committee are: Mr. W. Walker, acting chief inspector of mines under the Home Office (chairman), Dr. J. S. Haldane and Dr. H. Briggs.

DR. G. CARL HUBER, professor of anatomy in the University of Michigan, recently delivered an address on "Early Stages in Mammalian Development" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

Two courses of twelve lectures each on "The Designing and Computing of Telescope Systems" are being delivered at the Imperial College of Science, South Kensington, by Professor A. E. Conrady during this month and September. The lectures are given in connection with the newly formed department of technical optics under the direction of Professor F. J. Cheshire.

THE death is announced of M. Eduard Sarasin, of Geneva, editor of the *Archives des sciences physiques et naturelles*, and the author of numerous researches in physicial science.

BY an agreement between the executors of the estate of the late James Buchanan Brady and his heirs, the major part of his fortune, estimated at $3,000,000, becomes immediately available for the New York Hospital. This argeement enables the trustees and executors to carry out the testator's plans for the establishment of the James Buchanan Brady Foundation of Urology. Eventually a building will be erected for the foundation to cost about half a million dollars, which will include departments for investigation along chemical, bacteriological and pathological lines. The plans for the foundation are in the hands of Dr. Oswald S. Lowsley, who was named by Mr. Brady as director.

AT the annual general meeting of the Medico-Legal Society of London, when the President, Sir Samuel Evans, was in the chair, a recommendation of the council that aliens of enemy nationality should cease to be either honorary or ordinary members of the society, was unanimously approved.

THE British Museums Association proposes to hold a conference in October to discuss, among other subjects, local war museums and the Board of Education and museums.

PLANS for the one hundred and fifteenth meeting of the American Institute of Mining Engineers which include an inspection of the coal resources of Illinois, the zinc and other mining operations of Missouri, and the oil fields of Oklahoma have been announced. The meeting will be held during the week of October 8 to 13. Methods will be discussed for conserving the present supply and increasing

the output of the country's minerals which will prove of value in winning the war. The American Institute of Mining Engineers now numbers more than 6,000 members in every part of the country and in many parts of the world and representatives will be present of all the principal American mining centers. The program calls for several days' sessions in and around St. Louis and an inspection tour to the rich mineral Joplin-Miami district and the oil fields of Tulsa, Oklahoma. The engineers will be guests of the St. Louis section of the institute, the chairmen of committees including H. A. Buehler, state geologist of Missouri; F. W. De Wolf, Illinois, past president of the Association of State Geologists; James E. Caselton, St. Louis; A. H. Wheeler, St. Louis; E. F. Goltra, St. Louis. Philip N. Moore, of St. Louis, is president of the American Institute of Mining Engineers.

The Société de Chimie Industrielle has been founded in Paris to promote the science of chemistry as applied to industry. We learn from a statement in *Nature* that local provincial branches will be formed which, while being self-governing, will keep in touch with the parent society. The society will institute research work with the view of assisting manufacturers and agriculturists. An institute and library are in contemplation which will contain a complete collection of French and foreign periodicals devoted to industrial chemistry, and the society hopes to arrange for meetings, exhibitions, etc., to stimulate activity. A review—the first number of which is expected to be published shortly—will keep manufacturers posted in the latest developments at home and abroad, describe inventions and processes, and, generally, fill a want that has been long felt in France. The first council of the society contains many names prominent in the scientific and industrial world.

The War Council of the American Red Cross has established a Bureau of Sanitary Service under the direction of Dr. W. H. Frost. An appropriation of $800,000 has been made for the use of the bureau. This step has been taken in order to meet the new conditions which will arise as a consequence of bringing together so many men as will be mobilized throughout the country. The Bureau of Sanitary Service will supervise and aid in such operations as will tend to make health conditions about the camps as nearly ideal as possible. Increased forces will be provided for milk inspection, war will be made on malaria-carrying mosquitoes, and a radius of from fifteen to sixty square miles outside of the camps will be policed for the protection of the health of the men. Sanitary units will be furnished to the areas upon the request of the civil authorities.

The council of the British Medical Association has reported that the only possible method of placing the health administration of the country on a sound basis was by the creation of a Ministry of Health. Their recommendations are as follows:

That a ministry of health should be created to take over from existing government departments such duties as are concerned with the health of the community, and to deal with those duties only; that the administrative functions of the ministry should be carried out by a board presided over by a minister of Cabinet rank; that the country be divided into suitable administrative areas under local administrative health centers consisting of representatives (*a*) of the rating authorities; (*b*) of the education authorities; (*c*) of the persons contributing to a scheme of health insurance (including employers of labor); (*d*) the medical profession; (*e*) public hospitals; (*f*) dentists; (*g*) pharmacists, and (*h*) nurses; that the principal medical officers of each center should be two, of equal status, one representing the clinical side (chief clinical officer) and the other the preventive side of medicine (medical officer of health); that for each area, hospitals, clinics, or treatment centers should be recognized or established at which persons entitled to treatment under the public scheme should be able to obtain institutional, consultative or specialist services on the recommendation of their medical attendant.

UNIVERSITY AND EDUCATIONAL NEWS

For the Oklahoma College and Station a science building to cost $100,000 was authorized by the last legislature.

By the will of the late Sir Charles Holcroft a bequest of £5,000 is made to the University

of Birmingham, to establish a Charles Holcroft Research Fund.

FUNDS for the new chemical laboratories at University College, London, have been raised by a committee, of which Prince Arthur of Connaught is president and Captain the Hon. Rupert Guinness chairman and treasurer. The cost of the site, building and equipment will be £120,000. £100,000 has already been raised, leaving £20,000 to be found. In order to facilitate the immediate provision of this, Sir Ralph C. Forster, who has already subscribed generously to the cost of the laboratories, has promised £5,000 on condition that the remaining £15,000 is raised speedily.

A SCHOOL of Mines has been organized at Washington State College at Pullman. Under the new plan, the department of mining becomes one of the eight schools or colleges that comprise this state institution, and Professor Francis A. Thompson, head of the department, becomes dean of the School of Mines. Full facilities will be available for instruction in, and treating ores by, all standard forms of treatment, including leaching, amalgamation, concentration, roasting and smelting. A special laboratory will be devoted to the flotation process.

A. B. MCDANIEL, former assistant professor of civil engineering, University of Illinois, has been given administrative charge of the general engineering department of Union College, Schenectady, N. Y.

H. B. ELLENBERGER, Ph.D. (Cornell), has been appointed associate professor of animal and dairy husbandry at the College of Agriculture of the University of Vermont.

PROFESSOR HENRI ROGER has been appointed dean of the school of medicine of the University of Paris, to succeed the late Professor Landouzy.

DISCUSSION AND CORRESPONDENCE

TEACHING CHEMISTRY AND TEACHING CHEMISTS

LOOKING over the lists of chemistry courses offered in the various colleges and universities, one is impressed by the thoroughness with which the field has been covered. To suggest additions to the already long lists may seem, at first thought, uncalled for. There is a group of courses so obviously essential that we find them taught in every university, and there is a pretty clear understanding of what courses belong to this group. Supplementing this basic group are numerous courses extending and amplifying it in various directions determined by local influences, traditions and training of the staff members. The scheme has one serious defect, which is that there is seldom to be found in the whole list of courses, a single one designed to give the would-be chemist an intelligent and comprehensive idea of the science of chemistry, its history, literature, and rôle in a modern civilized world. A man who diligently pursues the courses offered will undoubtedly attain to a considerable knowledge of the laws, facts and theories of chemistry. Will he then be a chemist?

The writer was recently called upon to grade the examination papers of contestants for the Alpha Chi Sigma Scholarship Medal. There were eighteen contestants, representing ten prominent universities or colleges. Contestants were all in the second semester of the junior year and, since they undertook to compete in a scholarship examination, may be considered as somewhat more alert than their classmates. That grades attained would differ widely was to be expected. The sequence of courses is not the same in the schools represented, and various other factors contribute to make it difficult to get an adequate measure of the relative standing of students; but, allowing for all these, there was clearly shown a striking lack of information and of view point whenever the questions of the examination passed beyond the field of strictly chemical facts, laws and theories. A few examples will illustrate the point: Of the eighteen contestants, eight were unable to name a single American journal of chemistry, eleven were unable to name an English journal, thirteen could not name a French journal, and eight could not name a German journal. Of the eighteen contestants, only five could name a general treatise on inorganic chemistry; only nine could name such a work on organic

chemistry. Twelve of the eighteen could not name the president of the American Chemical Society. Only six of them knew of the recent work on the atomic weight of lead; only two of the eighteen could name three important chemical discoveries of the last ten years. Bunsen, Scheele, Wöhler, Ramsay, Mendeljeff were, to most of the contestants, just names of chemists who had done something or other. Required to name five prominent living chemists, most of them named three or four of the members of the local chemistry staff. Some of the men named are, indeed, prominent chemists, but when a student indicates that four out of five of the world's prominent chemists are included amongst his instructors, he is showing a lack of viewpoint rather than an intelligent loyalty.

It is far from the purpose of this note to belittle the knowledge of these students. They are, in all probability, more intelligent than the average. The point is that they should have, after three years of study in the field of chemistry, some knowledge of the use of a chemistry library, and more than a naïve understanding of contemporary chemistry. Perhaps we have expected them to absorb general chemical information from the atmosphere of a chemistry department. The actual situation is that their views of chemistry are hedged in between the covers of some ten or twenty text-books. If this is the case, would it not be worth while to add to our chemistry curricula a few courses—call them what you will—aimed squarely at supplying that body of general chemical information not to be found in text-books? To teach chemistry is one thing; to teach men to be chemists is a greater task.

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ANOTHER PHASE OF "ACADEMIC FREEDOM"

During the last few years there has been considerable agitation and many articles have been written upon the danger of loss of "academic freedom," by which is meant the right of college and university teachers to think and express their thoughts without fear of losing their positions through the possible unpopularity of their own opinions. All who are associated in any way with education realize the danger of political and financial overshadowing of independent thought, especially when it is opposed to the established order of things. It is evident, however, that there are still some who do not grasp the essential difference between the clerical attitude toward education a hundred years ago and the scientific attitude toward education to-day. A hundred or more years ago the imparting of information and of established creed was believed to be the entire function of the institutions of learning. To-day we advocate the stimulation of active, progressive thought which questions established ideas and is anxious to have before the mind all possible theories in order to further stimulate thought and investigation. A recent incident shows, however, that such is not by any means the attitude of all who should be leaders in freedom of expression of thought, but who are not.

In the December twenty-ninth issue of Science of last year a short item entitled "1916 or 1816?" calls attention to the fact that a certain literary society in one of our universities was announcing a phrenological lecture with the title "Brains—How to Know and Handle Them." The author of the note says simply at the end of his quotation of the announcement: "Comments would seem superfluous." However, it seems that they were not to him "superfluous," since in the January nineteenth issue of the same journal, under the caption "Phrenology," the same writer says, "It is *gratifying* to report the receipt of the following communication," which was signed by the dean of one of the colleges of the university. The letter quoted brings out the information that the author of the notes in Science wrote twice to the university protesting against the giving of the announced lecture on "Brains," with the result that the university president requested the literary society to cancel the lecture, which was forthwith done.

Now the fundamental consideration in the above-mentioned incident is not whether phrenology is a science, or whether it has any scientific basis, or even whether intelligent people should take note of it, but rather it is a question of the advisability of preventing, so far as possible, the expression before college students of views not generally believed by scientists. This lecture, be it noted, had no special sanction of the university, but was a private venture by a group of students in one of their own organizations. Certain it is that a phrenologist has a right to be heard and students not only have a right to hear, but they should be urged to, rather than hindered from, a careful investigation into the errors of any system. If the scientific facts opposed to phrenology are not strong enough to convince people of the fallacies of the subject, then surely no one has a right to prevent the expression of such ideas; and if the scientific facts are all opposed to the phrenological interpretation, then the artificial opposition on basis of authority is entirely useless as well as entirely unscientific. It may be argued that phrenology is not a modern, scientific theory, but an outworn superstition and hence should be discouraged. Without doubt superstitions should be discouraged, not by power of authority, but by scientific facts. Moreover, that which seems to be an outworn superstition may, in another form, appear later as a scientific theory, as for instance, the idea of the transmutation of metals. A few years ago a lecture on the "Transmutation of Elements" would no doubt have found many objectors who would have said that students should not have such foolish ideas placed before them. Now, however, such a lecture would be listened to with great interest because some scientists of high reputation vouch for the possibility of such transmutation. No idea should be smothered except by facts, for all the authority in the world, without good foundation of fact, may be as entirely wrong as the unauthorized idea expressed by the least known student. Further than this also we must go. Any idea, no matter how foolish it may appear, is worthy of attention as a means of stimulating thought and may even have a germ of truth which may develop into more truth by patient investigation. Let us demolish all superstitions as rapidly as possibly by the accumulation of scientific facts, but let us not hinder any propaganda by power of authority. College students should be encouraged to find out all the theories concerning any set of facts and then be led to a careful balancing of these by processes of logical thought.

ERNEST SHAW REYNOLDS

QUOTATIONS

WAR BREAD

THE public has been led to feel some anxiety concerning the effects of the present war bread upon national health and efficiency. Suggestion plays an inevitable part in such a connection. Certain untoward symptoms in individuals, for which some other tangible cause is not immediately evident, are liable just now to be ascribed on the slenderest evidence to the bread eaten. Once the belief in a deleterious influence has arisen, it is easy to understand how widely it may spread by suggestion. In the opinion of those best qualified to know, there would seem to be little basis for any such condemnation of the bread. It rests, nevertheless, with the food controller to obtain the best possible evidence concerning the facts, and we are glad to know that Lord Rhondda and the wheat commissioners have empowered a committee of the Royal Society to make a full and thorough investigation. This committee comprises some eminent medical consultants, as well as the physiologists who have been serving on the main food committee of the society. Its task is to decide whether the higher extraction of the grain can in itself be held responsible for any disturbance of health, and whether the admixture of other cereals with the wheat has produced a less digestible loaf, owing, for instance, to the associated difficulties in milling and baking.

Among other matters which are also engaging the attention of the committee is a greater tendency to "rope" in the bread, alleged to be due to the higher extraction of the grain. The

habits of *Bacillus mesentericus,* which, in its various strains, is responsible for ropy bread, are already well known to bacteriologists, and, empirically at least, to all the better informed among practical bakers. There is no reason to doubt that with the increased knowledge now being acquired any outbreaks of rope will in the future be easily controlled. That the presence in the loaf of cereals other than wheat can be directly harmful is most unlikely. A favorable effect should indeed be seen in a somewhat improved balance in the protein supplied. Maize, it is true, is said to be badly tolerated by certain individuals, though such cases must be rare. It is also stated that the starch of maize is not fully gelatinized when it is cooked in admixture with wheat under conditions suitable for the production of an all-wheat loaf.

These and other points will doubtless receive the attention of the investigating committee. Its most important task, however, will be to decide, by a thorough sifting of the evidence, the more general question as to whether the war bread is, as a matter of fact, producing any ill effects at all upon the public health. The public will be glad to know that the food controller is in possession of the facts.

Meanwhile, since it is of the utmost importance to the nation that a full supply of bread shall be maintained, while the amount of wheat available is not sufficient for the purpose, we are glad to observe that the medical press is urging the profession to see that the privilege of obtaining high-grade wheat flour for cases supposed to have suffered from the war bread is at any rate not abused.—*Nature.*

SCIENTIFIC BOOKS

The Human Worth of Rigorous Thinking. Essays and Addresses. By Cassius J. Keyser, Ph.D., LL.D., Adrain Professor of Mathematics, Columbia University. The Columbia University Press. 1916. Pp. vi + 314.

Six of the fifteen chapters of this volume appeared in Science during recent years,[1] while the remaining nine chapters, together with reprints of some of the six which had first appeared in Science, were published in various other periodicals or by the Columbia University Press. Hence the volume contains nothing new. Its value is due to the convenient form in which these inspiring essays and addresses are here presented. Unfortunately it contains no index and no table of contents besides the chapter or essay headings.

The title of the volume is the same as that of the initial essay, but some of the other essays contained therein could appropriately have appeared under the same heading, while the remaining ones represent somewhat more special developments along the same general line. Hence the title indicates truthfully the subject-matter of the entire collection. The volume might appropriately have appeared also with the following title: Inspiring thoughts relating to the history, bearing and educational value of mathematics with emphasis on the philosophical elements.

The pre-eminent ability of Professor Keyser along the line of presenting the fundamental elements of abstruse subjects in an elegant and popular manner is well known. His style appeals perhaps more strongly to non-mathematicians than to the majority of the mathematicians, who are often so exclusively interested in technical mathematical questions as to be but little concerned with elegance of language and the philosophical question of human worth. Teachers of mathematics should, however, bear in mind that to many of their students technical mathematical questions have little charm, and that some of these students could doubtless be reached by the more subtle but no less real historical and philosophical questions connected with their subjects.

Hence the volume before us can be highly recommended for the prospective teachers of mathematics, as well as for those who are interested in the general cultural values of various scientific subjects. The professional mathematician will, however, also find therein much that is presented from a somewhat new

[1] On page 220 it is stated that Chapter XII., on the "Principia Mathematica," had been printed in Vol. XXV. of Science. It actually had appeared in Vol. XXXV., 1912, and Vol. XXXVII., 1913.

point of view and that throws new light on the philosophical questions which permeate the various mathematical developments. Among the chapters which might appeal especially to such readers we may mention those bearing the following headings: "The axiom of infinity," "Mathematical productivity in the United States," and "Concerning multiple interpretations of postulate systems and the 'existence' of hyperspace."

In Chapter IX. Professor Keyser discusses "Graduate mathematical instruction for graduate students not intending to become mathematicians," arguing that such courses need not presuppose a first course in calculus, but could be based upon the mathematical preparation gained in a year of collegiate study. He would begin such a course "with an exposition of the nature and function of postulate systems and of the great rôle such systems have always played in the science, especially in the illustrious period of Greek mathematics and even more consciously and elaborately in our own time."

The headings of the nine chapters which have not been mentioned in what precedes are as follows: "The human significance of mathematics," "The humanization of the teaching of mathematics," "The walls of the world; or concerning the figure and the dimensions of the universe of space," "Mathematical emancipation; dimensionality and hyperspace," "The universe and beyond; the existence of the hypercosmic," "The permanent basis of a liberal education," "The source and function of a university," "Research in American universities," and "Mathematics."

Some of these titles are the subjects of addresses delivered by Professor Keyser before large audiences, and many of those who recall his stimulating language will doubtless welcome the opportunity to secure a collection covering such a wide scope of interests which are common to all, but which should appeal especially to those devoted to the borderland between philosophy and mathematics. One finds here a mixture of the most modern theories and the emotional descriptions of past generations, a charming flow of language illuminating most recent advances and, above all, an inspiring tableland of thought which is easily accessible to all but which is closely related with fundamental questions of education.

The mathematicians, as a class, are perhaps too much inclined to put off the historic, philosophic and didactic questions for later consideration, following the example of the great mathematical encyclopedias which are in course of publication. As a result the majority of them become so engrossed in the technical developments of their subjects as to find little time for the postponed questions of the most fundamental importance—a fate which seemed to threaten the encyclopedias just mentioned. A work in which some of these fundamental questions are handled in an attractive manner is therefore a valuable and timely addition to the mathematical literature.

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EQUATIONS AS STATEMENTS ABOUT THINGS

IN the teaching of elementary physics and mathematics, much trouble is often caused by the fact that students who can readily solve an equation given them are unable to formulate in mathematical terms the data occurring in a practical problem. The purpose of this paper is to report briefly the results of several years' experience with a plan designed to remove as much as possible of this trouble by making the equations show more readily their meanings as shorthand statements of the facts. While there is probably nothing about these ideas that has not been suggested before, such suggestions, when applied at all to teaching, seem to have been rather vague and incomplete, or else applied only to one branch of the subject. In this case the plan to be outlined has been used in a general course of physics and in a course in mechanics, with results much more satisfactory than those obtained by the ordinary method.

To illustrate the difference between the old plan and the new, let us consider a single equation, the falling body law

$$s = \tfrac{1}{2} g t^2.$$

On the old plan, such an equation is merely a set of instructions for the computation of s. If the body has fallen three seconds, the student is expected on the old plan to write

$$s = \tfrac{1}{2} \times 32 \times 3^2 = 144.$$

This process, simple as it appears to the teacher, is not so simple for the student, as it really involves identifying t as the *number of seconds* the body has fallen, g as the *number of ft./sec.*^{2} in the gravity acceleration, performing the computation and then interpreting the result as a *number of feet.* One obvious cause of trouble is the necessity for using certain definite units on each side, with the errors made by the use of the wrong units; and another, perhaps not so obvious, is the fact that the formula itself is not a statement about a real distance of so many feet, a real acceleration of so many ft./sec.^{2} and a real time of so many seconds, but about pure numbers, mere incomplete "so many s," the most abstract things yet invented by man. Under these conditions is it surprising that a freshman fails to formulate his data into mathematical equations?

On the new plan, the equation is taken as a statement about actual concrete things. In this particular case, the computation would take the form,

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times 3^2 \text{ sec.}^2 = 144 \text{ ft.}$$

The interpretation of the formula is now that s is physically a result of the combination of the gravity acceleration g with the time t, which enters once in producing the final velocity gt, and mean velocity $\frac{1}{2}gt$ and again in combination with this mean velocity to give the distance $\frac{1}{2}gt^2$. The essential feature in the application of this plan is the insertion of each quantity as a *quantity*, that is, as *so many times another quantity of the same kind*, and not as a mere "so many."

If in computation the boy should happen to forget to square t, he would get

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times 3 \text{ sec.} = 48 \frac{\text{ft.}}{\text{sec.}},$$

an obviously impossible *kind* of answer. But if he departs from the above method only in calling $t = \frac{1}{20}$ min., he gets

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times \frac{1}{20^2} \text{ min.}^2 = \frac{1 \text{ ft. min.}^2}{25 \text{ sec.}^2}.$$

To reduce this to simpler terms he has only to substitute 60^2 sec^2 for min^2, exactly as he would perform any other algebraic substitution of equals, and then cancel the sec^2 and finish the computation. Or, if he lets

$$g = 22 \frac{\text{min.}}{\text{hr. sec.}},$$

he gets

$$s = \tfrac{1}{2} \times 22 \frac{\text{min.}}{\text{hr. sec.}} \times 3^2 \text{ sec.}^2$$

$$= \tfrac{1}{2} \times 22 \frac{\text{min.}}{3600 \text{ sec.}^2} \times 3^2 \text{ sec.}^2 = \tfrac{11}{100} \text{ min.},$$

which is as correct an answer as the other. To reduce units the game is simply to substitute equals for equals and cancel. If this does not give the right kind of an answer, it is a sure indication of an error.

Of course, to play the game fairly, we must abolish formulas with lost units, such as $s = 16t^2$. Examples of these are found most frequently in electricity. The old plan would write such a formula as that for the force on a wire in a magnetic field, as $F = IlH$ with a string of restrictions on units, or $F = \frac{1}{10}IlH$ with another string. By forgetting the restrictions and using the simpler formula with the most familiar units, the students often achieve remarkable results. On the new plan this would be written $F = KIlH$ where

$$K = \tfrac{1}{10} \frac{\text{dyne}}{\text{amp. cm. gauss.}}$$

and all restrictions are removed. It is of of course true that this form of the equation involves more writing than the others; indeed, it may be noted here that the process of treating all equations as physical statements is not necessarily worth while for trained men doing routine computations, but it is extremely useful for all sorts of cases where the computations are not familiar enough to be classified as routine work. For all such cases it is well worth while to write out the proportionality constant, especially if some one is likely to want l, say, in inches or F in kilograms.

In the detailed application of this principle, there is one point where confusion might arise, though it can readily be avoided. It is the anomalous behavior of the unit, radian, which appears as a perfectly respectable unit when an angular velocity is converted from $\frac{\text{rev}}{\text{min}}$ to $\frac{\text{sec}}{\text{rad}}$ but does not appear when the same angular velocity is found from $\frac{v}{r}$. This anomaly is the only one of its kind, and is not nature's fault, but our own. If we define angle as degree of opening, to be measured in units of the same kind, the substitution method outlined above is the most natural method of converting say $\frac{\text{rev}}{\text{min}}$ to $\frac{\text{rad}}{\text{sec}}$. If, on the other hand, we define angle as a mere ratio of arc to radius it is necessarily a pure number (like a sine or a tangent). If we swap horses in midstream, we shall either miss this unit later or else see it floating up where we do not expect it. This means we must insert or rub out the unit radian whenever it is convenient to do so. Fortunately angle is the only quantity treated in such a way.

For the sake of such mathematical purists as may not approve of the above on philosophical grounds, a few words should be inserted here on the meaning of the term "multiplication." In elementary arithmetic it means merely repeated addition, but with the introduction of irrational numbers the term is extended by mathematicians to an operation that is not strictly repeated addition. The plan here advocated extends the notion of multiplication still further, to cover a physical combination of concrete quantities. In general the definition of multiplication in each individual case amounts to translating into algebra the ordinary verbal definition of the compound quantity involved (area, velocity, work, etc.). This extension is made practicable by the fact that the operation thus defined obeys the same logical postulates as the corresponding algebraic operation on pure numbers. In other words, the machinery of mathematics can be applied not merely to numbers, but to any group of concepts and operations satisfying the same postulates. This fact is accepted intuitively by most students; and incidentally the emphasis it puts on the definitions prevents most of the well-known confusion between acceleration and velocity, power and work, and so on.

To sum up, it seems to me after several years' experience with this system, that it has the following important advantages: (1) It treats equations as neat shorthand statements about real physical things and emphasizes the esthetic side of mathematics in general; (2) It provides an enlarged principle of dimensions by which equations may be checked during computation; and (3) It removes completely all restrictions on the units to be used and enables the student to concentrate his attention on the facts of nature without the disturbing influence of arbitrary rules.

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SPECIAL ARTICLES

ON THE SWELLING AND "SOLUTION" OF PROTEIN IN POLYBASIC ACIDS AND THEIR SALTS

THERE are available only scattered observations on the absorption of water by proteins in the presence of various polybasic acids and their salts. In order to obtain further experimental data in this field, we undertook a rather detailed study of this problem during the past year. As examples of proteins, dried gelatin discs and powdered fibrin were used. For the polybasic acids we chose phosphoric, citric and carbonic. In connection with the swelling of gelatin, we studied also its "solution." The general results of our experiments may be summed up as follows.

I

The amounts of water absorbed by gelatin from equimolar solutions of monosodium, disodium and trisodium phosphate depend not only upon which of these salts are present, but upon their concentration. Gelatin absorbs but little more water in a solution of monosodium phosphate than it does in pure water.

In low concentrations of disodium phosphate, gelatin swells decidedly more than in pure water, but as these lower concentrations give way to higher ones, the gelatin swells less and less until, when sufficiently high concentrations are attained, the gelatin swells decidedly less than in pure water.

These same general truths may be stated for trisodium phosphate, except that the absolute amounts of water absorbed in solutions of this salt are, at the same molar concentration, decidedly higher than in the case of the disodium salt. Low concentrations of trisodium phosphate bring about much greater swelling than higher ones. With progressive increase in the concentration of the trisodium salt, there is a progressive decrease in the amount of swelling until a concentration is finally reached in which the swelling is decidedly less than in pure water.

Having studied in this fashion the relation of swelling to type of salt and its concentration, we investigated next the amount of water absorbed by gelatin in phosphate mixtures of compositions varying from the extreme of pure phosphoric acid on the one hand through mono-, di- and trisodium phosphate to pure sodium hydroxid on the other. These mixtures were made in different ways. Beginning with pure phosphoric acid, we added successively greater quantities of sodium hydroxid, or beginning with sodium hydroxid, we added successively greater amounts of acid until the theoretical neutralization had been accomplished; or we began with pure acid and replaced this with more and more of the mono-di-, or trisodium phosphate until the opposite extreme of a pure alkali was reached; or we began with a definite concentration of any one of the phosphates and added progressively greater amounts of either acid or alkali. The results in all these expriments were practically the same. In 24 to 48 hours the gelatin attained its maximal swelling (practically). When the amount of swelling is plotted on the vertical and the changes in the composition of the solutions from acid through the mixtures of the mono-, di- and trisodium salts to pure alkali on the horizontal, a curve, roughly V-shaped, is obtained. Greatest swelling is observed in the pure acid solution and least in a solution consisting essentially of monosodium phosphate. From this point on, there is a gradual increase in the swelling of the gelatin until the disodium salt is passed, when there occurs a more abrupt rise until the trisodium salt is reached, beyond which the curve rises still more steeply until the sodium hydroxid end of the series is attained.

The swelling of gelatin in monosodium, disodium and trisodium citrate follows the same general laws as its swelling in the corresponding salts of phosphoric acid. Monosodium citrate in all concentrations increases somewhat the swelling of gelatin over the amount of swelling in pure water. The same is true of low concentrations of disodium citrate. But the higher concentrations of this salt depress the swelling to below that attained in pure water. These statements also hold for the trisodium salt. As we succeed in getting more base into the citrate, there appears a distinctly greater tendency to depress the amount of water absorption.

In studying the amounts of water absorbed in citrate mixtures varying between the extreme, on the one hand, of pure citric acid, through mono-, di- and trisodium citrate to pure sodium hydroxid, we observed that the results (when amount of swelling is plotted on the vertical and progressive change in composition of solution on the horizontal) yield a U-shaped curve. Greatest swelling is obtained in the pure acid, the amount of this swelling decreasing progressively as we approach the monosodium salt. From the monosodium to the disodium salt the curve falls more gently, until a minimal point is reached in a mixture of about equal parts of monosodium citrate and disodium citrate. From here on, the curve rises gradually to the trisodium salt, after which it ascends steeply as we pass toward the extreme of the pure alkali.

We have also studied in this fashion the effects of carbonate mixtures. As the sodium bicarbonate in a pure solution of this salt is gradually displaced by a molecularly equivalent amount of sodium carbonate, and this

in its turn by an equivalent of sodium hydroxid, the amount of water absorbed gradually increases in the form of the right arm of the letter U. Swelling is least in the pure sodium bicarbonate, increases slowly in the sodium carbonate and then more rapidly as this is replaced by sodium hydroxid. The swelling of gelatin in pure sodium bicarbonate is slightly higher, in the concentration employed by us, than in pure water.

II

Practically the same findings as have been detailed for gelatin in the paragraphs given above were encountered when the swelling of fibrin was studied in different concentrations of the pure salts or in mixtures of these, varying between the extremes of acid on the one hand and alkali on the other.

III

It has been pointed out in previous papers[1] that the swelling of a protein and its liquefaction or "solution" are totally different processes. The "solution" of gelatin is, in other words, not merely the extreme or a continuation of the swelling of a protein. We were able to verify these results in studying, in parallel with the swelling of gelatin in polybasic acids and their salts, its "solution" under the same circumstances.

When gelatin containing a unit amount of water, and solid at ordinary room temperature, has mixed with it phosphoric acid, phosphate mixtures or sodium hydroxid in the concentrations already discussed above, it is found that the "solution" or liquefaction of the gelatin parallels its swelling. In other words, gelatin remains solid in phosphate mixtures of various kinds, but tends to lose in viscosity, to liquefy and to remain fluid as we pass from the phosphates in the direction either toward acid or toward alkali.

IV

We hold these experiments to be corroborative of, and to bear upon notions previously expressed regarding the importance of acids, of alkalies, of various salts and of these in mixture in determining the amount of water absorbed by protoplasm under physiological and pathological conditions. The well-established qualitative and quantitative analogy between the absorption of water by various hydrophilic colloids (like the proteins) and isolated cells, organs or organisms, whether of animal or vegetable origin, shows that protoplasmic water absorption is essentially a colloid-chemical phenomenon. These studies with polybasic acids and their salts therefore bring further proof of the importance of an abnormal production or accumulation of acids within such colloid systems for increasing the amount of water thus held, and so of explaining the mechanism by which the abnormally high hydrations of living cells are brought about as observed in edema, excessive turgor and plasmoptysis, or in those various "diseases" which are in essence only edemas of the involved organs like nephritis, glaucoma and "uremia." These experiments also show how coincident with, but not synonymous with the increased swelling there also occur a "softening"[2] and an increased "solution" of the colloids of the involved tissues, thus explaining further the "softening" of organs after an initial swelling together with the appearance of increased amounts of colloid (like protein) in the fluids bathing or expressed from the involved edematous tissues (albuminuria, excessive protein content of spinal fluid in edemas of the central nervous system, increased protein content of serous accumulations, etc.).

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May 30, 1917

[1] Martin H. Fischer, SCIENCE, N. S., Vol. XLII., p. 223 (1915); *Kolloid Zeitschr.*, Vol. XVII., p. 1 (1915).

[2] For a discussion of tissue softening as due to the breaking of an emulsion see Martin H. Fischer and Marian O. Hooker, SCIENCE, N. S., Vol. XLIII, p. 468 (1916); "Fats and Fatty Degeneration," 76, New York, 1917.

NOTES ON MITES ATTACKING ORCHARD AND FIELD CROPS IN UTAH[1]

During the summers of 1915 and 1916 while making investigations for the laboratory of the American Smelting & Refining Company, Department of Agricultural Investigations, I found certain mites to be particularly abundant and destructive to grains in Utah.

The most important of these was the common *Tetranychus bimaculatus* Harvey, which Ewing believes is the same as *T. telarius* Linn. The host list for this species, as Ewing has pointed out, is a long one, and it is an important pest on a surprisingly large number of crops. In 1916 it was so abundant in orchards that many cherry trees were completely defoliated before the end of August, and apricot, pear, plum and apple trees were only a little less seriously affected. Raspberry and currant bushes suffered severely, some of them losing all of their leaves. Peas, beans, tomatoes and other kinds of garden truck showed more or less injury in all stages of their development, and in one field of sugar beets, I found many leaves drying and turning brown on account of the attacks of this mite. The loss of the foliage of many ornamental plants, while not of so much economic importance, was, of course, a very annoying thing.

Corn probably suffered more than any other field crop. In many fields practically every plant suffered the loss of some of its leaves, and in other places all of the leaves turned brown and became thoroughly dry because of the presence of the myriads of mites that covered the undersides of the leaves. The parts of the fields where the soil was lighter and dryer usually suffered most, but no parts seemed to be immune from the attacks of this pest. The suckers and lower leaves were the first to be attacked and to show the brown spots or streaks where colonies of the mites were feeding. When the trouble went no further it was of but little economic importance, but when the upper leaves were attacked and practically all destroyed the plant withered and was not even good for fodder.

[1] Contribution from the laboratories of the American Smelting and Refining Co., Department of Agricultural Investigations.

Many wheat fields also sustained considerable losses due to the attacks of the same mite. The wheat plants would usually be attacked a short time before the head burst from the sheath and when the infestation was bad the leaves would become dry and brown at the point of attack and the portion of the leaf beyond this would droop down and dry out. Often all of the leaves would be affected in this way and the heads, if they developed at all, would be small and poorly filled.

Earlier in the season, while the wheat plants were much smaller, they were often attacked by two other species of mites. One of these is the well-known clover mite, *Bryobia pratensis*. The other has been called the jumping mite on account of its habit of quickly folding its legs and dropping from the plant when disturbed. Banks in *Proc. Ent. Soc. Wash.*, Vol. 14, p. 97, named this species *Tetranychus longipes*. A letter dated June 29, 1915, says that he now places it with two others in a new genus, *Tetranobia*. He refers to this genus again in his bulletin on "The Acarina or Mites" (Rept. No. 108, U. S. Dept. Agric. Office of Sec., pp. 33 and 38) but the formal description of the genus has not yet been published. The common name, jumping mite, is somewhat misleading, for the mite does not actually jump, but, when alarmed, it folds its legs quickly and may thus be thrown a short distance from the spot where it was feeding. In fields where the mite is abundant the leaves turn distinctly gray and many of them become so dry that the growth of the plant is seriously affected. Both *B. pratensis* and *Tetranobia longipes* were found destructively abundant not only on wheat, but on barley, oats and many wild grasses.

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THE OCCURRENCE OF MANNITE IN SILAGE AND ITS POSSIBLE UTILIZATION IN THE MANUFACTURE OF EXPLOSIVES

During the course of our investigations on the fermentation processes that occur immediately after the ensiling of corn, and the chemical products resulting therefrom, it was found

that mannite could be isolated from practically every sample of normal corn silage. The alcoholic extract from dried silage yielded, on evaporation, considerable amounts of mannite, which after one recrystallization gave the characteristic crystals melting at 168–169°. That the presence of mannite can not be considered a local phenomenon is shown by the fact that silage samples obtained from a number of other states in the middle west all contained mannite. The only previous reference to the occurrence of mannite in silage is in a paper by Manns,[1] published a quarter of a century ago. In his work, however, only one sample of silage was examined and the approximate amount of mannite found was not stated.

The following table shows the amount of mannite actually isolated by us from samples of silage obtained from various sources:

Date	Source	Material	Mannite. (Per Cent. on Air-dry Basis)
Feb. 20	Iowa	Corn silage juice	1.30
Mar. 14	Wisconsin	Corn silage	1.70
Mar. 20	Nebraska	Corn silage	2.07
Mar. 21	Minnesota	Corn silage	2.51
Mar. 27	Minnesota	Corn silage	1.47
Mar. 27	Illinois	Corn silage	2.15
Mar. 23	Missouri	Silage from immature corn	0.52
Mar. 20	Kansas	Cane silage	3.30
May 17	Montana	Sunflower silage	5.61
Apr. 16	Arkansas	Corn and cowpea silage	none
Mar. 2	Illinois	Sweet clover silage	none
May 11	Iowa	Ensiled corn stover + sucrose 30 days	3.04
Feb. 21	Iowa	Ensiled corn stover + sucrose 13 days	2.12
May 27	Iowa	Ensiled green corn 10 days	1.72
Feb. 21	Iowa	Ensiled corn stover + glucose 30 days	none

It will be noted that the highest percentages of mannite are to be found in the sunflower silage, the cane silage and the experimental corn silage to which sucrose had been added. Evidently the mother substance of the mannite is sucrose, or more specifically its fructose moiety.

The production of mannite no doubt reaches a maximum soon after filling the silo and then some loss probably occurs, owing to further bacterial activities. However, the amount of mannite is still considerable when the silage is several months old.

If it is desired to prepare quantities of mannite without reference to an approximately quantitative yield, the method may be much simplified. The silage is put in a powerful press, the juice filtered, evaporated to about one sixth of its volume and two or three volumes of alcohol added. The mannite then crystallizes out, and the alcohol can be recovered in the usual way. In this manner it should be possible to extract the mannite on a large scale at very little cost. The pressed residue and the mother liquor could be combined and used for feeding in place of the original silage, since practically nothing would be removed but the mannite and the volatile acids.

Mannite yields a nitration product very similar in properties to nitroglycerin. According to Sanford,[2] "Nitromannite is more dangerous than nitroglycerin, as it is more sensitive to shock. It is intermediate in its shattering properties between nitroglycerin and fulminate of mercury. . . . It is not manufactured upon the commercial scale."

The reason nitromannite is not made commercially is probably the prohibitive cost of mannite. Prepared by the above method from silage, mannite should be even cheaper than glycerin, especially if the residues are utilized as cattle feed. The thousands of tons of silage used every year by the farmers of this country could be made to yield a valuable by-product if treated by this simple process.

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[1] Illinois Ag. Exp. Sta. Bulletin, No. 7, pp. 190–193.

[2] Nitro-Explosives, p. 110, D. Van Nostrand Co., 1906.

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE sixteenth annual meeting of the North Carolina Academy of Science was held at the University of North Carolina on Friday and Saturday, April 27 and 28, 1917. At 2:30 P.M. the executive

committee met, passed on the report of the secretary-treasurer, elected 10 new members, and selected the State Normal College, Greensboro, as the next place of meeting. At 3 P.M. the reading of papers was begun and continued until 5:30, when adjournment was had. Reconvening at 8 P.M., the academy was welcomed to the university by Dean Andrew H. Patterson, after which President F. P. Venable, of the academy, delivered his presidential address, "The structure of the atom." Next Professor Collier Cobb gave a lecture on "Typical early maps of North Carolina" illustrated by lantern slides of some of the maps in question. The academy then adjourned to the hospitable home of Professor W. C. Coker for a highly enjoyable smoker.

The annual business meeting of the academy was held at 9:15 Saturday morning. Reports of the secretary-treasurer, the executive and other committees were made. On motion a committee was appointed to cooperate with a similar committee from the Science Section of the North Carolina State Teachers' Association in studying the subject of the teaching of high-school sciences in the state with reference to its increased efficiency. The secretary reported on his visit to the meeting of the Southern Association of Colleges and Secondary Schools and his appearance in behalf of the work in science before its committee on the curriculum of secondary schools. On motion, the secretary was again appointed as the representative of the academy at the next meeting of this association. After some discussion it was declared the sense of the meeting that an increased effort be made in 1918 to bring into the membership of the academy as many as possible of the high-school teachers of science in the state.

The following officers were elected for 1917–18:

President—W. A. Withers, State Agricultural and Engineering College, West Raleigh.

Vice-president—J. H. Pratt, University of North Carolina, Chapel Hill.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—Bert Cunningham, High School, Durham; H. R. Totten, University of North Carolina, Chapel Hill; H. C. Beardslee, Asheville School, Asheville.

At 10:50 a joint meeting was held of the academy and the North Carolina Section of the American Chemical Society for the reading of the papers of common interest to both bodies. Following this, papers were read before the academy until the program was finished at 1:40, when the members were entertained by the university at luncheon in Swain Hall. Of the 20 papers on the program not one was read by title. Counting the 10 new members, the total membership of the academy is 84, of whom 37 were present at this meeting. Including the presidential address, which will be published in the current number of the *Journal of the Elisha Mitchell Scientific Society*, the following papers were read:

Pliocene deposits in Orange county: John E. Smith.

These occur on the divides and on the higher terraces in the plateau section of the county and generally over the Triassic area except on the floodplains and on the steeper slopes near the streams.

On the upland (elevation, 500–600 feet) this material consists of smooth, rounded pebbles and cobbles (some of which are polished) of quartz and quartzose minerals up to six inches or more in diameter, together with fragments of the same and of other minerals down to the size of soil particles. In the Triassic area (elevation, 250–400 feet) the deposit comprises gravel, sand and soil (in addition to the above) in some places reaching a thickness of a foot or more. This material has been transported from a distance and characterizes the Granville soils, distinguishing them from those of the Penn series, which are derived from the Triassic rocks in place.

The thinly distributed pebbles on the higher divides of the county may be remnants of river deposits on a peneplain, but the soils, etc., of the lower interstream areas are doubtless of Lafayette age. (Illustrated with lantern slides.)

The pollination of Rotundifolia grapes: L. R. Detjen.

A close examination of the flowers of *Vitis rotundifolia* brings out the fact that this species of grape is not at all adapted to cross-pollination by means of the wind; on the contrary, it seems to indicate that insects alone are responsible for the transportation of the pollen. Bees of the family Andrenidæ and beetles of the species *Chauliognathus marginatus* were tested for their propensities of transporting pollen and for the searching for flowers of the fruit-bearing varieties.

The test was made by enclosing insects, newly captured on flowers of staminate vines, separately in spacious cloth bags together with clusters of open but unpollinated flowers. The results secured substantiate the hypothesis of insect pollination. They further indicate that bees of the fam-

ily Andrenidæ are probably the most effective pollinators of the vine and that beetles are of only minor importance. Bees of the family Megachilidæ are also active workers and undoubtedly contribute considerably toward the production of fruit.

Saprolegnia anisospora in America: W. C. COKER.

This species has not before been reported in America. We have found it twice in Chapel Hill, in marshy shaded places containing algæ. It is distinguished chiefly by the following characters:

1. The presence of spores of two or three sizes, borne usually in separate sporangia without regard to the size of the latter; the small spores from 10.5–11 μ in diameter, the large ones from 13.7–14.8 μ in diameter. In nearly all cultures there are formed a few very large spores, at least twice the size of the ordinary large ones, these appearing mixed in with the latter.

2. The irregular shape of the sporangia, which are not evenly cylindrical, but more or less waved, bent and constricted, and which proliferate either laterally from below as in *Achlya,* or within the old ones, as is usual in *Saprolegnia.*

3. In sexual reproduction numerous oogonia are formed, each with one or more antheridia of diclinous origin.

The jaws of the great barracuda, Sphyræna barracuda: E. W. GUDGER.

A careful description, illustrated by photographs and a specimen, was given of the teeth and jaws of this fish. Their use was briefly described and some accounts of the ferocity of the fish narrated. In the waters of southern Florida it is generally more feared than the shark, being bold and inquisitive where the shark is cowardly. The data presented are part of a paper now in press in a volume of memoirs from the Tortugas Laboratory of the Carnegie Institution at Washington.

The status of the science work in the high schools of North Carolina (lantern): S. J. MARION.

This survey and report will be published in full in the forthcoming issue of the *North Carolina High School Bulletin.*

Armillaria mellea, Clitocybe cespitosa, Pleurotus sapidus and Claudopus nidulans in pure culture: H. R. TOTTEN.

The fact that the spores of *Armillaria mellea* and *Clitocybe cespitosa* (*C. monodelpha*) have two walls, while the spores of *Pleurotus sapidus* and *Claudopus nidulans* have only one wall is plainly shown in the sprouting spores. Mycelia of the four mushrooms were shown in pure culture on several media, also drawings of the mycelial threads as seen under high power. *Armillaria mellea* forms a slow-growing, closely flocculent, cream-colored mat, and soon produces long, brown to black, root-like rhizomorphs. In agar these rhizomorphs are beautifully shown radiating from the mat-like central mass. The mycelium of *Clitocybe cespitosa* is much like that of *Armillaria mellea,* but the threads are not so closely woven and the rhizomorphs, or root-like bodies, are white. It is shown that *Armillaria mellea* and *Clitocybe cespitosa,* while very closely related, are not the same. The mycelium of *Claudopus nidulans* is silkier and is from white to pink in color. The mycelium of *Pleurotus sapidus* except in old cultures is loose and silky and is very fast growing, soon covering the medium with a mass of pure white threads. Fruiting bodies of both *Pleurotus sapidus* and *Claudopus nidulans* were shown developing in pure cultures.

Structural geology of Orange county, N. C.: JOHN E. SMITH.

With few exceptions the rocks of this county occur in long, narrow belts and "islands" extending north 65° east. Named in their order from the southeast these areas comprise the Triassic sedimentaries, granite, diorite, rhyolite, schists and greenstone, diorite, schists and phyllite, greenstone and schists, diorite, schists and greenstone, diorite, granite.

The structure of these rocks is that of a syncline whose trough centers along the line of strike and passes near Cheek's Siding about three miles east of Mebane. Measured along the dip this syncline is approximately twenty miles wide and probably contains folds of minor importance within it. The major joints, flow lines, etc., of the igneous rocks in many places parallel both the dip and the strike of the schists belts. Inclusions of the diorite in the granite attest the greater age of the former and the presence of belts of igneous rocks beneath the margins of the syncline certify their contribution to the structure and prove the greater age of the schists, etc. South of Chapel Hill beyond Morgan Creek the strike is due east and west and the conglomerates, slates and rhyolites dip to the south at an angle of 65°. (Illustrated with maps, charts and structure sections.)

State regulation of the sale and manufacture of gas: C. W. EDWARDS.

In 1910, out of 228 cities in the United States of more than 25,000 population, only 47 had no requirements such as are in a bill proposed for North Carolina. Of these 228 cities, 103 are

under state laws and have no additional municipal regulations. A number of cities such as Baltimore, Buffalo, Los Angeles and Milwaukee have local provisions in addition to state laws. In 1910, sixteen states had laws providing for the state inspection of meters and of the purity of gas—Connecticut, Georgia, Kansas, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Vermont, Virginia, Washington, Wisconsin and California (B. of S. Circular No. 32). Doubtless the list is now larger.

In 1910 the net income to the state of Massachusetts in meter-testing alone was over $5,000. The total cost of the tests on quality, purity, pressure, etc., was assessed on the operating companies according to their sales. Meter-testing is on the fee basis. There is no good reason why such a department in North Carolina would not yield a revenue to the state.

That the Corporation Commission in North Carolina should have the power and machinery at its command to protect the interests of citizens seems obvious for the following reasons: Under existing law it is the duty of the commission to regulate the rates to be charged by gas companies. The proper price is determined in a large measure by the quality of product sold and this is almost at the will of the producer. Gas in New York City furnishes 680 heat units per cubic foot and is sold at 80 cents. Gas in Durham furnishes at times less than 500 heat units and is sold at $1.50. In one city in this state gas furnishing 412 heat units sold for $1.60. The standard requirement in regulated states is around 600 heat units. The difference in quality means a loss of from five to twenty thousand dollars per year to consumers in various towns of this state and the loss would easily run into hundreds of thousands to the state at large. While it may be to the interest of certain communities to sell a cheap, poor gas it is safe to say that it is always against public interest to have a cheap, poor gas sold at a rich, high price. To fairly meet its responsibility the commission must know from its own tests the quality of the product sold. The consumer is entirely helpless.

Aside from the question of rates, the public is vitally interested from the standpoint of health. In the method of manufacture used by one company in this state, carbon monoxide and hydrogen are produced in equal quantities. Both of these gases are odorless and one is a deadly poison. Combined they give a cheap gas furnishing about 300 heat units. This gas causes a meter to register just as fast as a 600 heat unit gas. It is the duty of this company to carburet this gas with an oil which not only brings its heat value to standard, but gives it a very pungent odor that makes it noticeable in case of a leak. In this town a series of fatal accidents have occurred due solely to the neglect of the service company. In other methods other deleterious elements are introduced by carelessness so that in all cases public interest demands systematic testing under the authority of the state.

It is just as reasonable to let manufacturers sell anything called fertilizer without tests as to composition as it is to permit of the sale of untested gas. Our duty to test meters is just as obvious as our duty to test weights and measures.

The advantages resulting from such an act would not even be principally with the citizen. An expert employed by the state to travel from plant to plant observing and testing, corrects irregularities and errors in manufacture that may mean thousands of dollars saved to the companies. If ammonia appears in the gas it means that a valuable by-product is being lost. So it is with other errors of manufacture. The fact that meters are tested by the state brings a feeling of confidence to the consumer that is worth much to the gas companies. Uniform, improved and economical manufacture brings new and profitable business and this more than compensates for any costs involved.

No abstracts have been received for the following papers:

The relative toxicity of uranium nitrate in animals of different ages, by Wm. DeB. MacNider.

Trembles, by Frederick A. Wolf.

Permanency in fleshy fungi, by H. C. Beardslee.

Sound-wave photography (lantern), by Andrew H. Patterson.

Evolution in sponges and changes in classification, by H. V. Wilson.

The revision of the atomic weight of zirconium, by F. P. Venable and J. M. Bell.

Recent investigations about cottonseed meal, by W. A. Withers and F. E. Carruth.

The physics of the shrapnel shell, by Andrew H. Patterson.

Portolan charts (lantern), by Collier Cobb.

The idea of force in mechanics, by Andrew H. Patterson.

The times we think in, by George W. Lay.

The life history of the pecan trunk borer, by R. W. Leiby.

E. W. Gudger,
Secretary